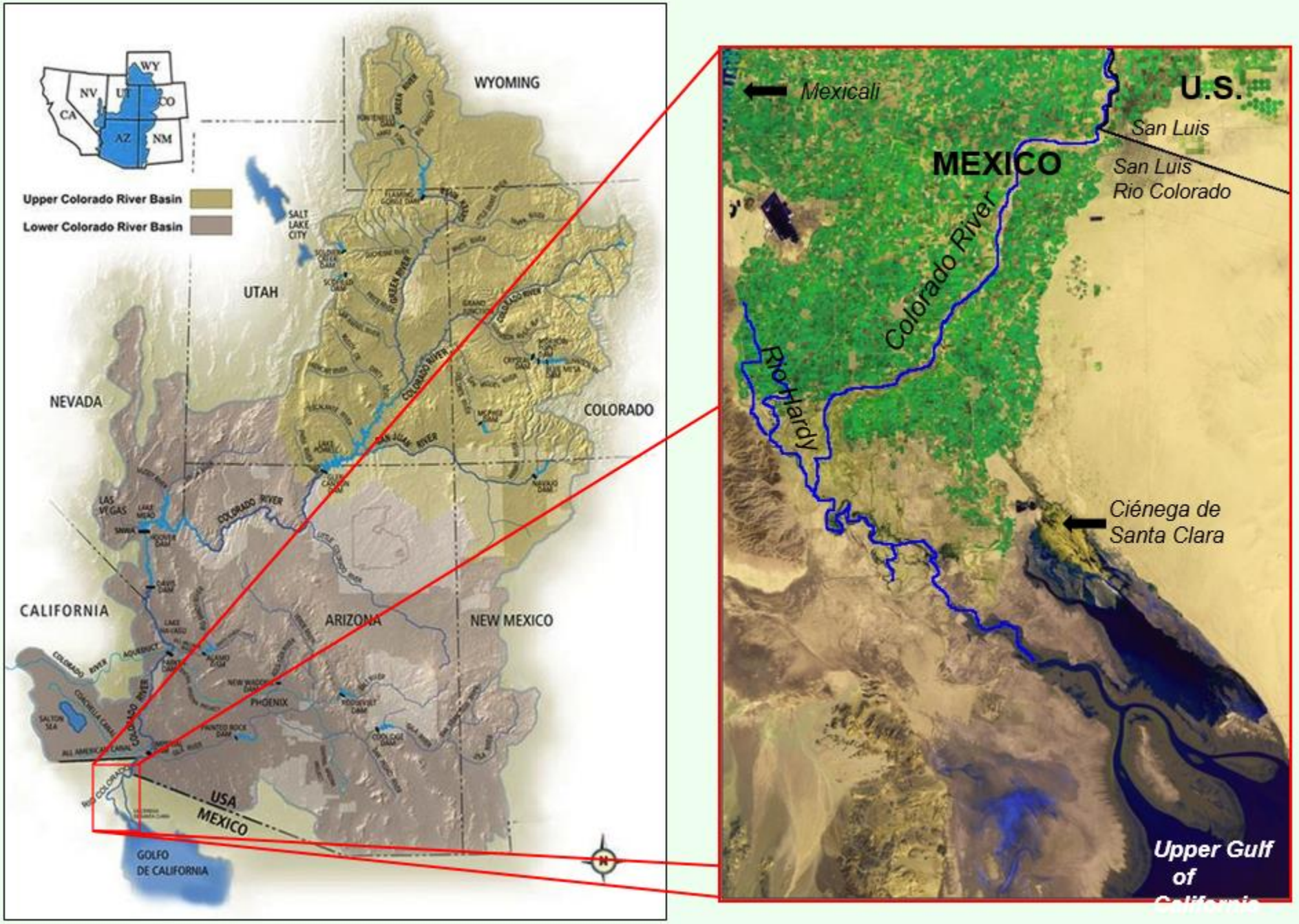
The Vegetation Response to Environmental Flows and Restoration Actions in the Colorado River Delta

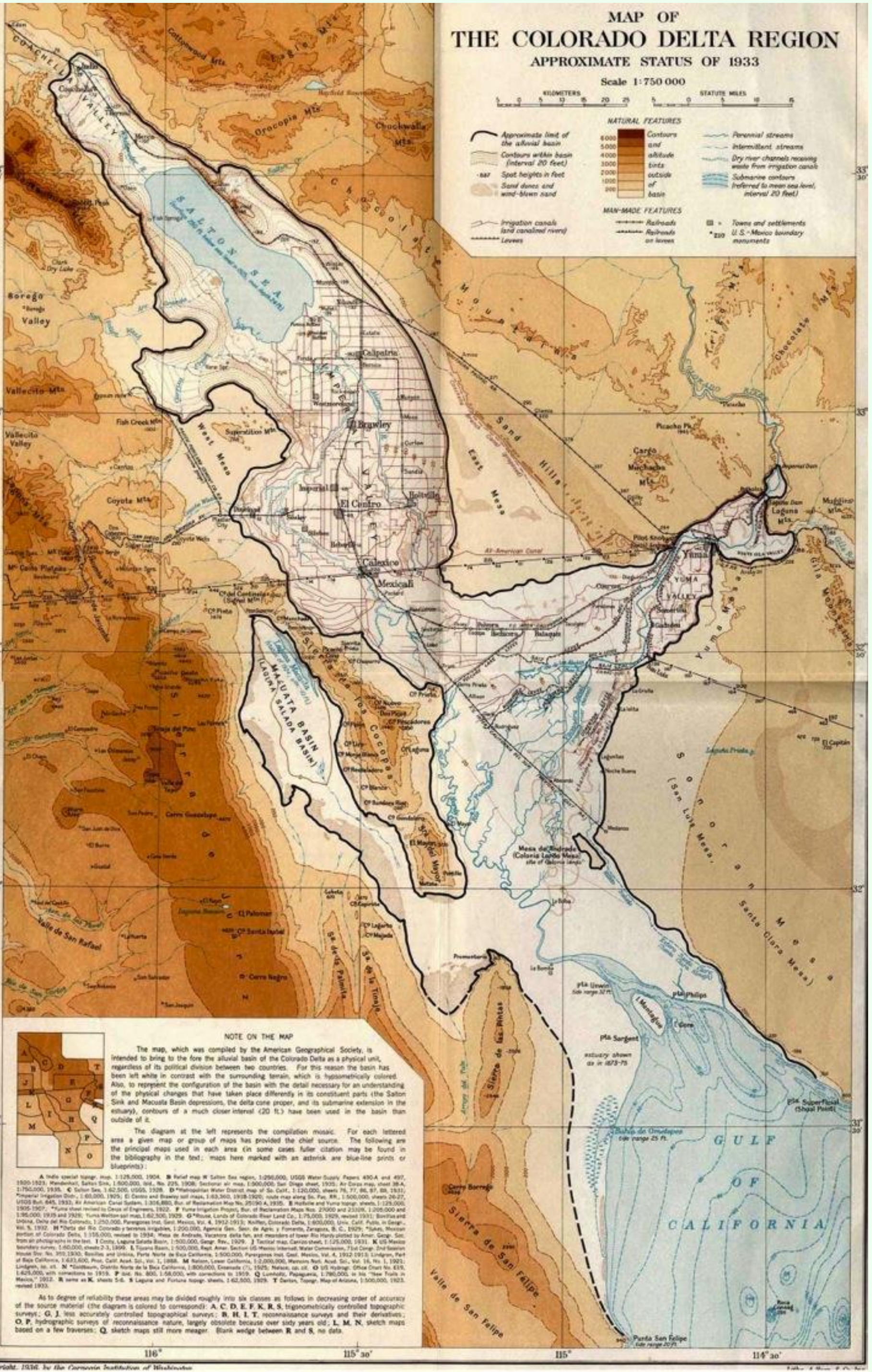
Karen Schlatter, Project Manager
Colorado River Delta Program, Sonoran Institute
Email: kschlatter@sonoraninstitute.org
And the Minute 319 Science Team

SONORAN INSTITUTE

The Minute 319 Science Team

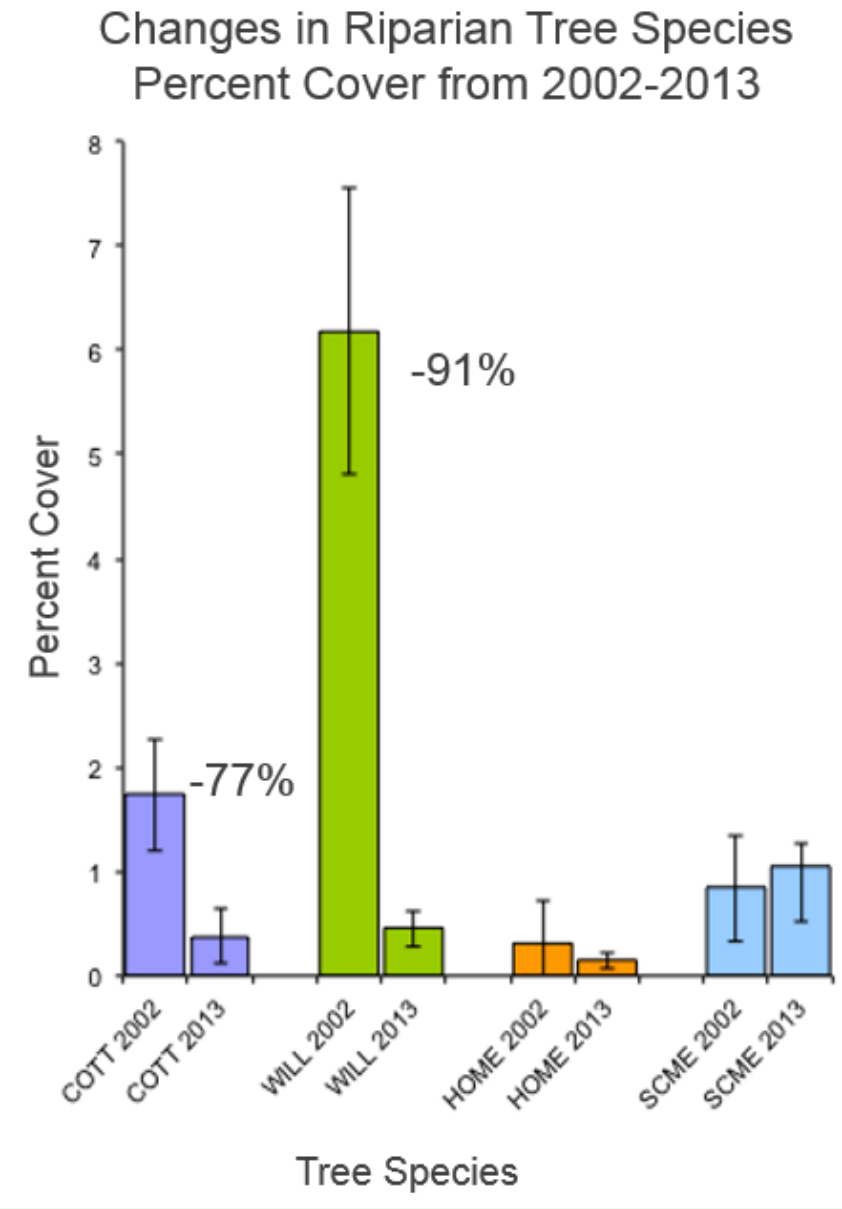
Karl Flessa, University of Arizona
Carlos de la Parra, Colegio de la Frontera
Ed Glenn, University of Arizona
Osvel Hinojosa, Pronatura Noroeste
Eloise Kendy, The Nature Conservancy
Jeff Kennedy, USGS
Jim Leenhouts, USGS
Jeff Milliken, US Bureau of Reclamation
Erich Mueller, USGS
Pamela Nagler, USGS
Steven Nelson, Unaffiliated
Karen Schlatter, Sonoran Institute
Jack Schmidt, USGS, Utah State University
Pat Shafroth, USGS
Margaret Shanafield, Flinders University
Dale Turner, The Nature Conservancy
Jorge Ramirez, Universidad Autónoma de Baja California
Eliana Rodriguez, Universidad Autónoma de Baja California
Francisco Zamora, Sonoran Institute


WY
NV
UT
CO
CA
AZ
NM
Upper Colorado River Basin
Lower Colorado River Basin
WYOMING
SALT LAKE CITY
UTAH
NEVADA
COLORADO
CALIFORNIA
ARIZONA
NEW MEXICO
LAS VEGAS
PHOENIX
COLORADO RIVER
GREEN RIVER
SAN JUAN RIVER
USA
MEXICO
GOLFO DE CALIFORNIA
Mexicali
U.S.
San Luis
MEXICO
San Luis Rio Colorado
Colorado River
Rio Hardy
Ciénega de Santa Clara
Upper Gulf of


MAP OF
THE COLORADO DELTA REGION
APPROXIMATE STATUS OF 1933
Scale 1:750 000
NATURAL FEATURES
MAN-MADE FEATURES
NOTE ON THE MAP
SALTON SEA
GULF
OF
CALIFORNIA


United States
Mexico
Arizona
Mexico
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
Reach 7
Laguna Grande Restoration Area
Gulf of California
Mexicali
El Centro
Yuma
San Luis Rio Colorado
Puebla
Tecolote
Somerton
Guadalupe Victoria
5 0 5 10 km
Legend
Colorado River
Bordo de protección
Bordo
Reach 1 - Upper Limitrophe
Reach 2 - Middle Limitrophe
Reach 3 - Dry Reach
Reach 4 - Central Delta
Reach 5 - Braided Reach
Reach 6 - Rio Hardy
Reach 7 - LCR and Upper Estuary

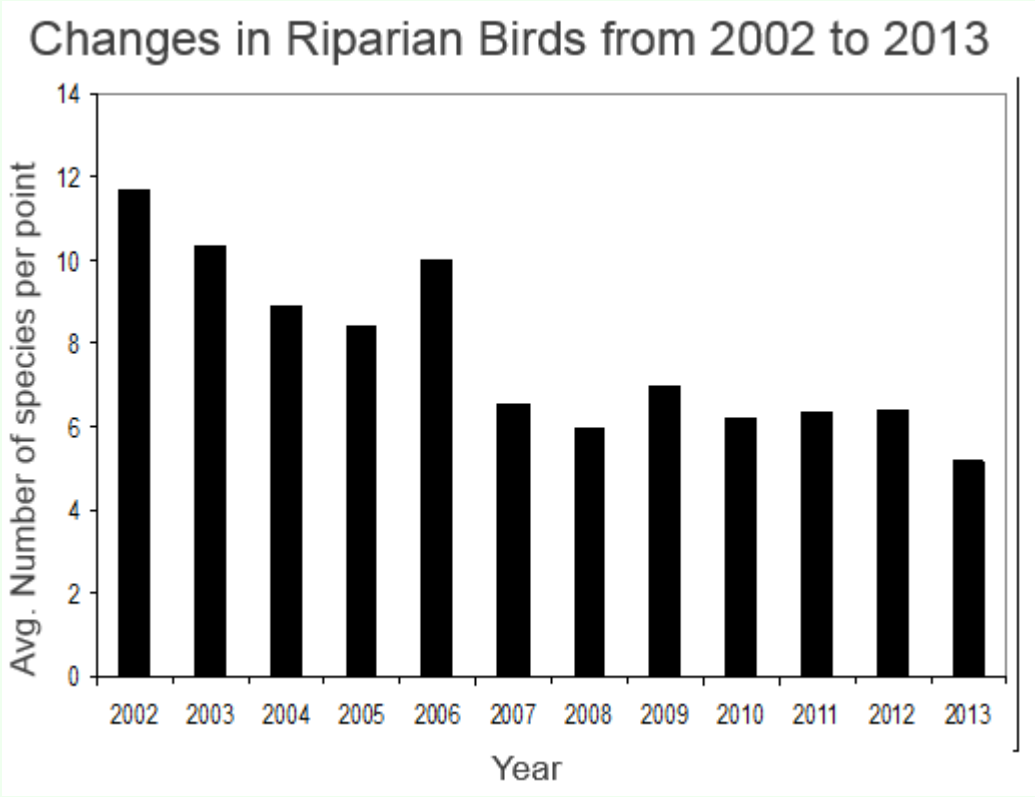
Vegetation in the Delta



From 2002-2013:

- Avian diversity (N2) decreased 55.8%
- Decrease in percent cover of native tree species

Preliminary data provided by Pronatura Noroeste



Minute 319

- 5-year agreement signed in November 2012 by US and Mexico
- Establishes new guidelines for the management of Colorado River water during times of drought and promotes investments in water conservation projects
- Water dedicated for ecological flows to the Colorado River in Mexico for the 1st time in history
- Total water to be dedicated to Delta: 158,088 acre-feet (af)
- Delta Water Trust to provide 52,700 af for river base flow; 105,400 af provided by US and MX for flood pulse flow
- NGO goal is to restore over 2300 acres of habitat by end of term
- At end of 5-year term, US and MX will determine if/how to expand commitments

Passive Restoration:

- Natural germination and establishment of native species

“Assisted” Passive:

- Nonnative species removal
- Opening of river meanders, grading
- Natural germination and establishment of native species
- Base flows

Active Restoration:

- Nonnative species removal
- Furrowed
- Planted with native species
- Irrigated

Minute 319 Restoration Goals

Active Restoration:

Site Name	Restoration Target (acres)
Miguel Aleman	250
Km 27	50
Chausse	135
Laguna Grande	405
Total for corridor	840

Passive Restoration Target (corridor wide): 2300 acres

Area restored in Colorado River riparian corridor in Mexico to date:

(both Minute 319 and non-Minute 319 sites)

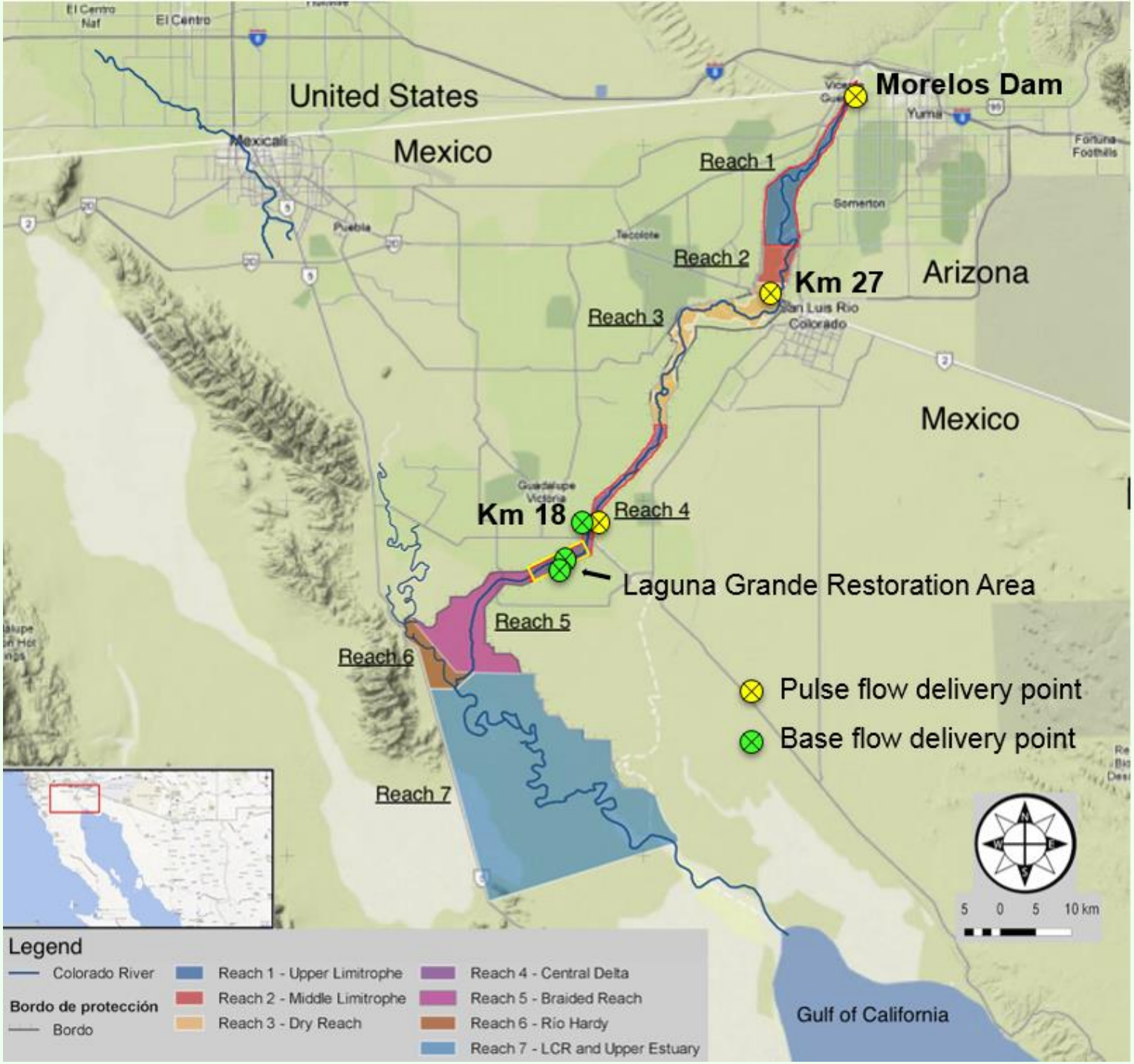
Site Name	Area Restored (acres)	Organization implementing restoration
Miguel Aleman	25	Pronatura Noroeste
Laguna Grande	200	Sonoran Institute






Minute 319 Pulse Flow: March 23-May 18, 2014 – 105,000 acre-feet (130 mcm)

Minute 319 Base Flows: 2012-2017: 52,000 acre-feet (65 mcm)


United States
Mexico
Morelos Dam
Reach 1
Reach 2
Km 27
Arizona
Reach 3
Mexico
Km 18
Reach 4
Laguna Grande Restoration Area
Reach 5
Reach 6
Reach 7
Pulse flow delivery point
Base flow delivery point
Gulf of California
5 0 5 10 km
Legend
Colorado River
Bordo de protección
Bordo
Reach 1 - Upper Limitrophe
Reach 2 - Middle Limitrophe
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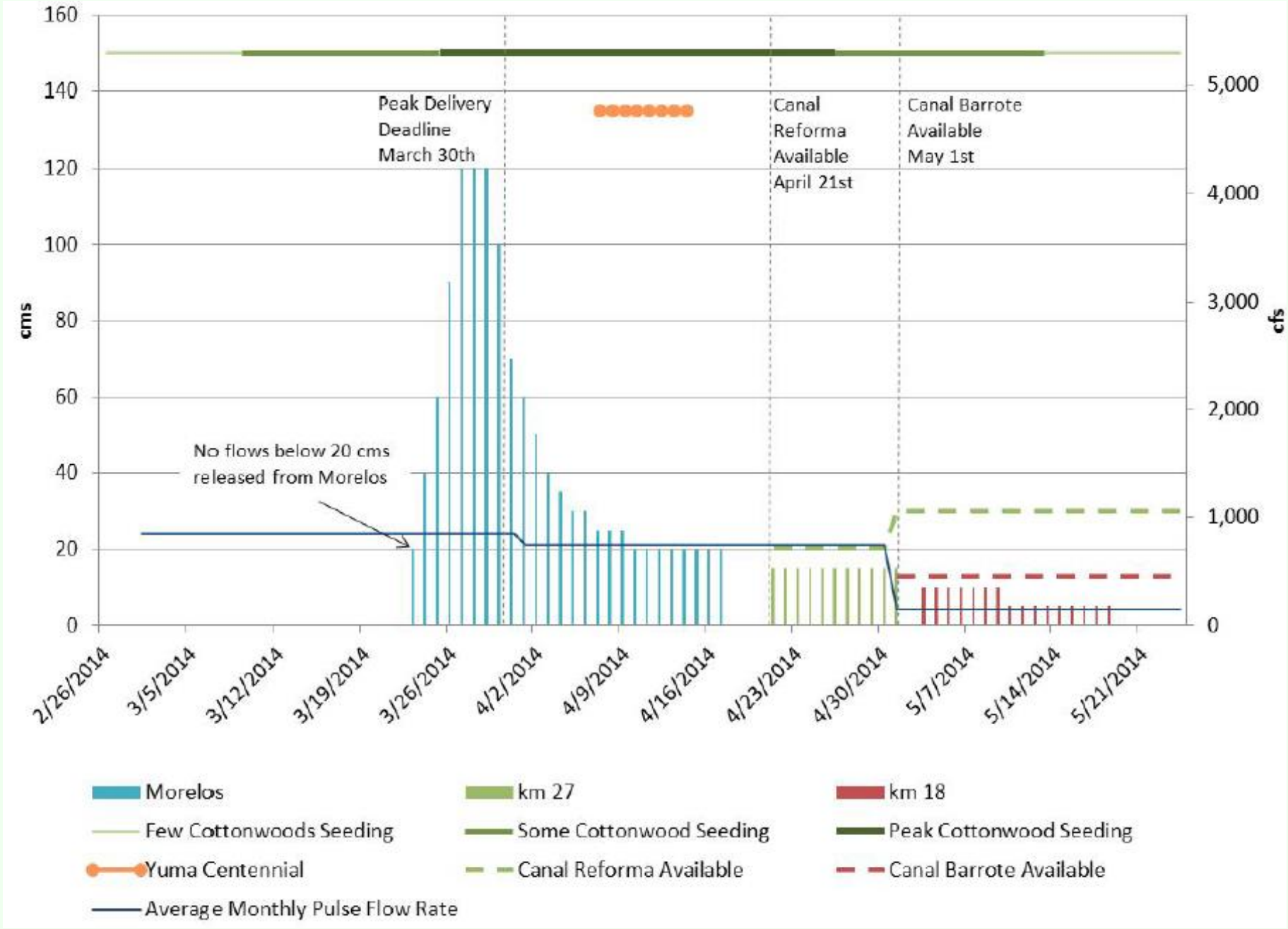
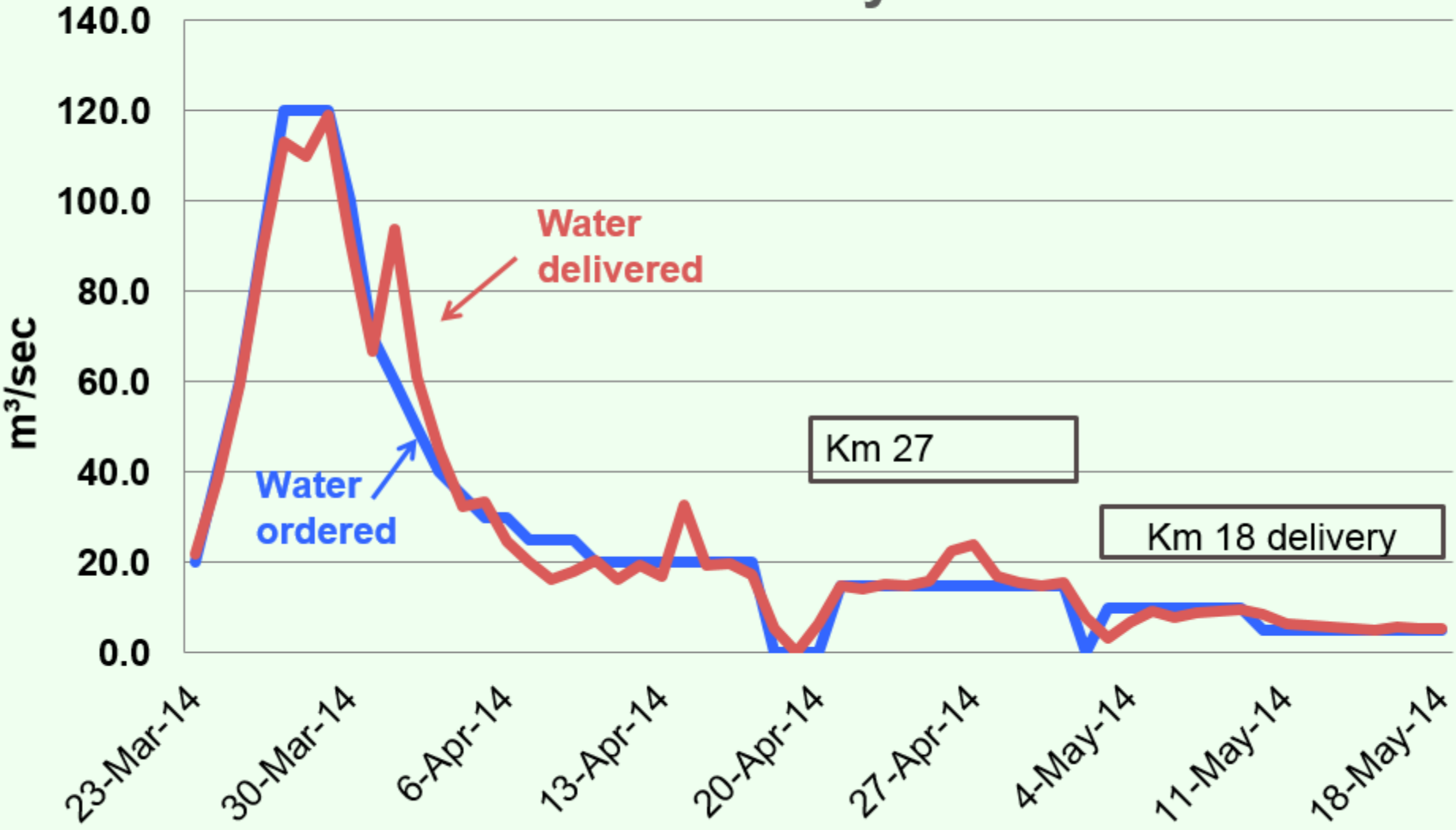
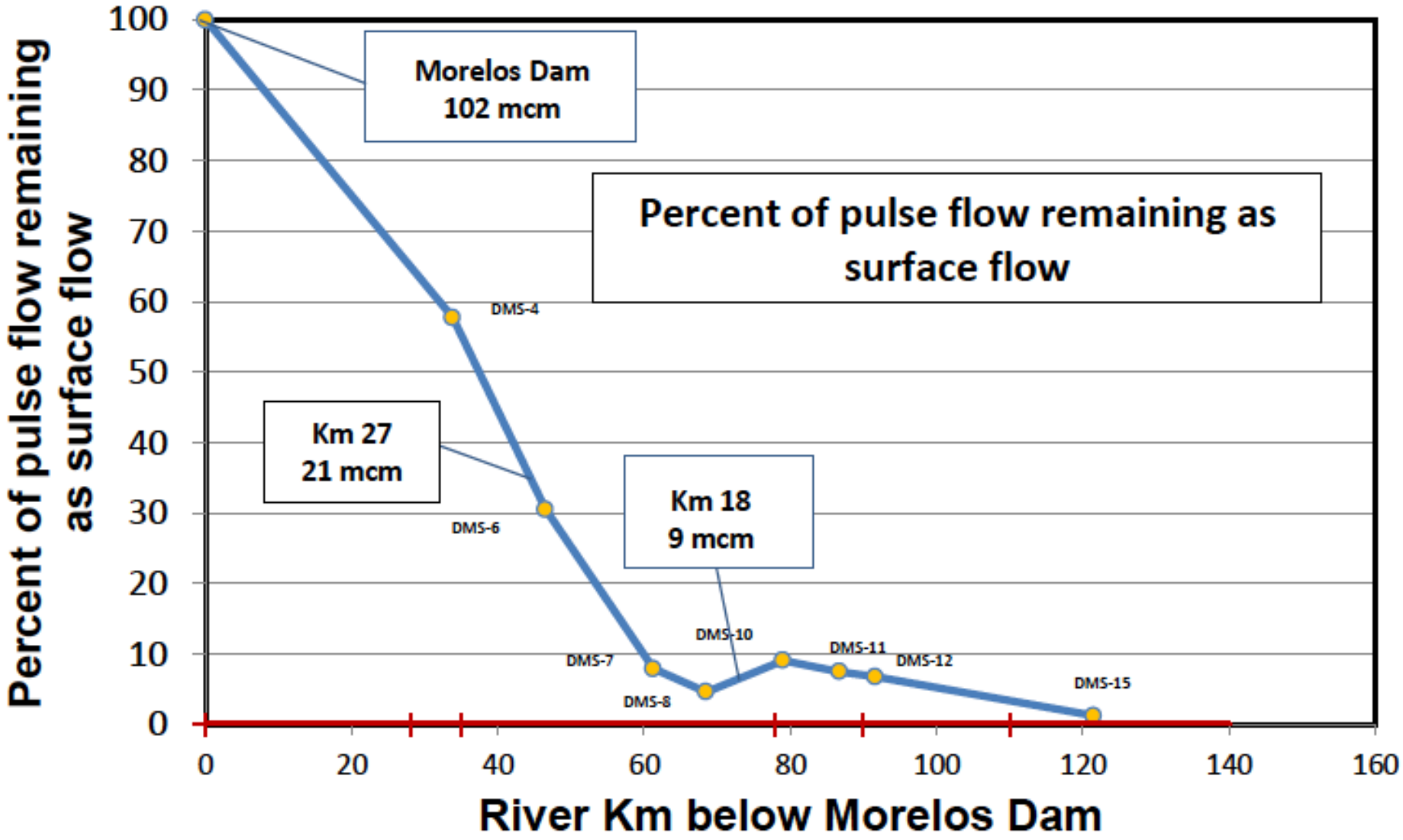

160
140
120
100
80
60
40
20
0
cms
5,000
4,000
3,000
2,000
1,000
0
cfs
Peak Delivery
Deadline
March 30th
Canal
Reforma
Available
April 21st
Canal Barrote
Available
May 1st
No flows below 20 cms
released from Morelos
2/26/2014
3/5/2014
3/12/2014
3/19/2014
3/26/2014
4/2/2014
4/9/2014
4/16/2014
4/23/2014
4/30/2014
5/7/2014
5/14/2014
5/21/2014
Morelos
km 27
km 18
Few Cottonwoods Seeding
Some Cottonwood Seeding
Peak Cottonwood Seeding
Yuma Centennial
Canal Reforma Available
Canal Barrote Available
Average Monthly Pulse Flow Rate

Pulse Flow
March 23 – May 18 2014

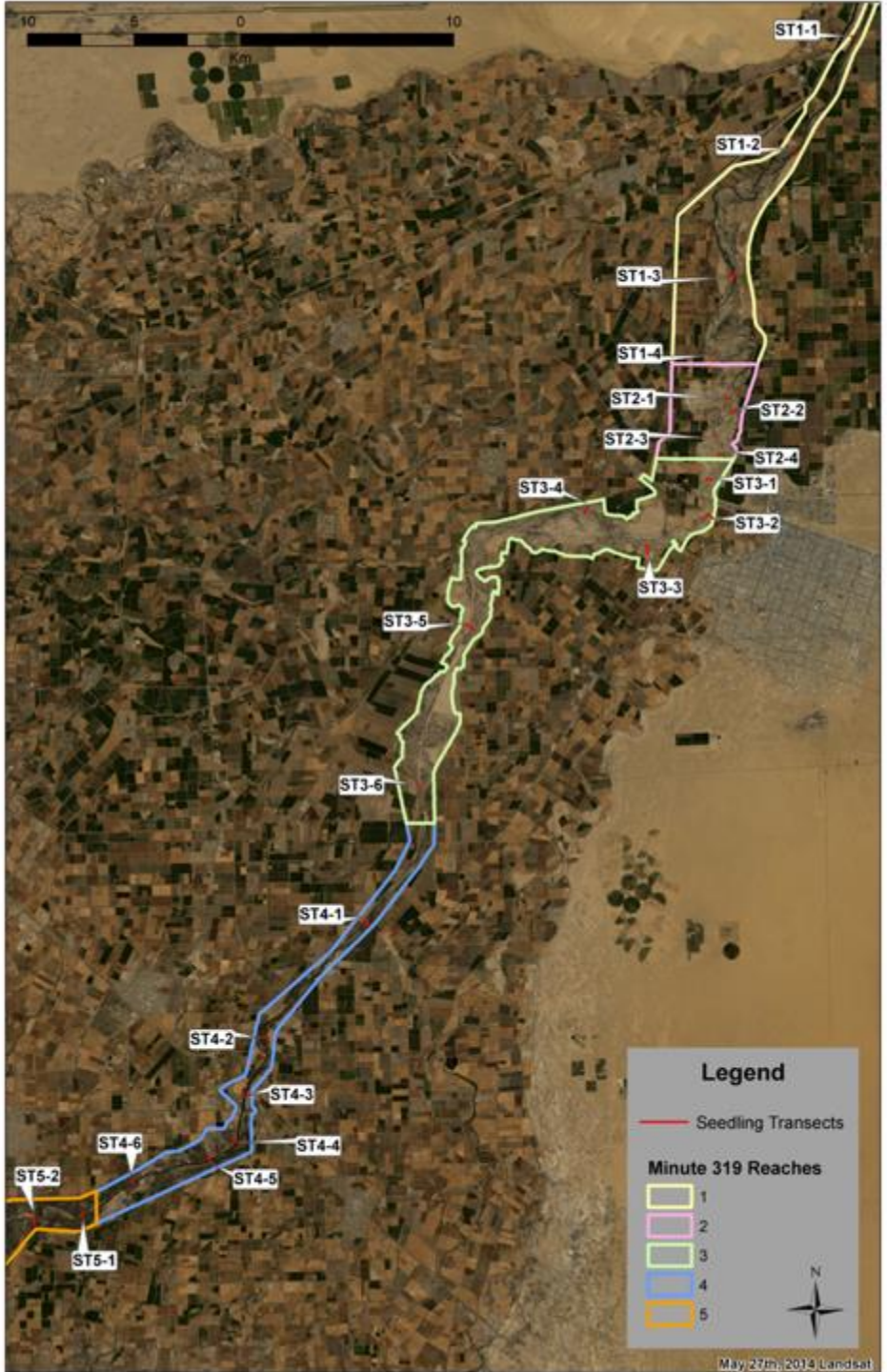




Pulse flow water rapidly soaked into dry river bed

Seedling transects

- Located in Reaches 1-5
- 22 transects co-located with piezometers
- The following was measured:
  - Seed dispersal timing and abundance
  - Pre- and post-pulse vegetation
  - Seedling locations and densities
  - Pre- and post-pulse topography
  - Pre- and post-pulse soil texture and salinity



Methods:

Seed traps: monitored sticky traps every 2-3 weeks from early March through mid-June.

Vegetation surveys: conducted in March, May and October 2014; line-intercept method (1m belt) on transect to estimate plant cover by species.

Topographic surveys: Pre- and post-pulse flow RTK topographic surveys.

Soil texture and salinity: surface soil samples collected within primary topographic/geomorphic surfaces.

Preliminary Results:

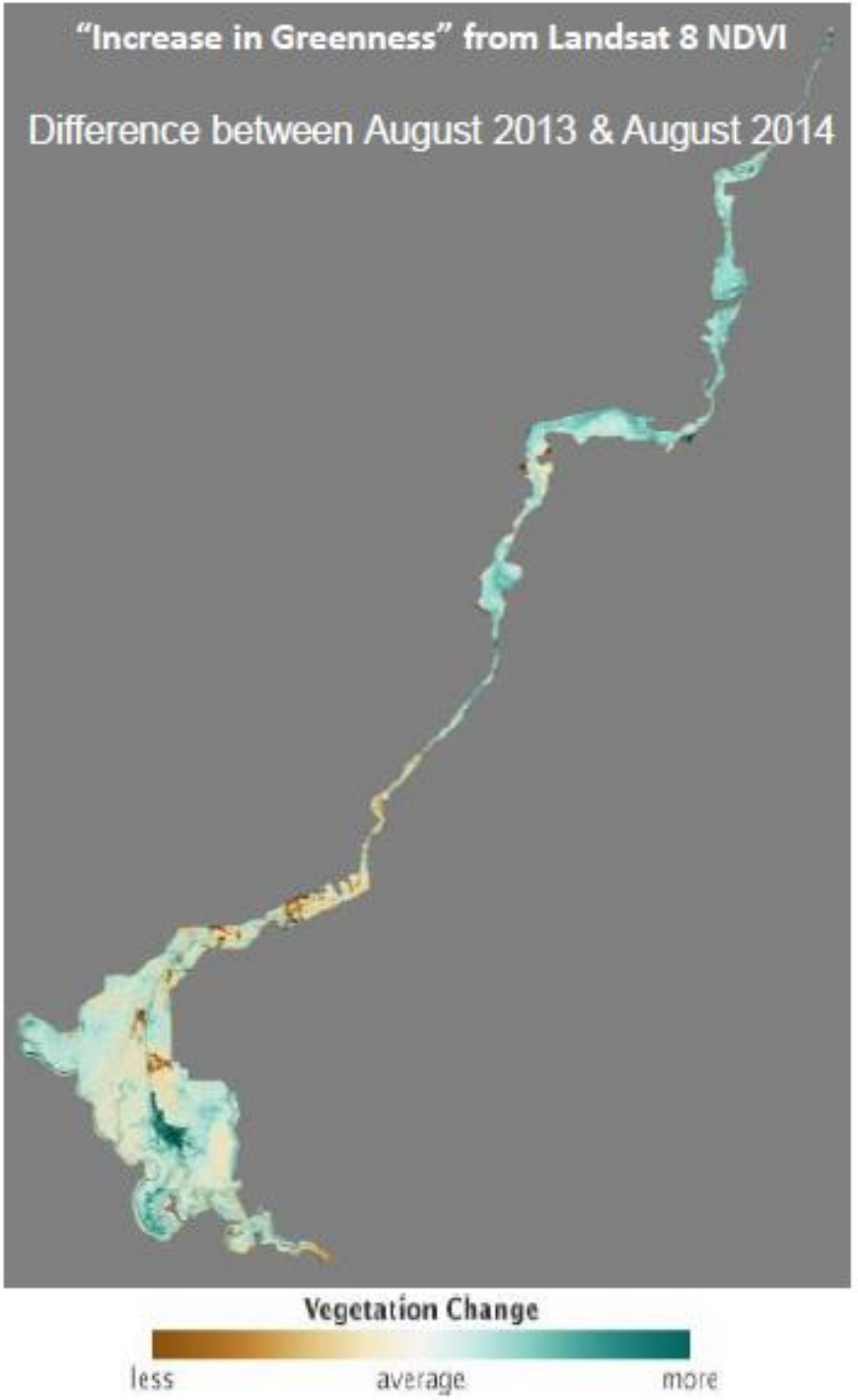
Table 1. Number of patches where seedlings were detected in one-meter (3.3 ft) belt on the line intercept (May surveys)

	Reach				
Seedling species	**1**	**2**	**3**	**4**	**5**
Goodding's Willow	1	2	0	2	0
Fremont Cottonwood	9	0	0	1	0
Screwbean Mesquite	2	0	0	2	0
Baccharis spp.	11	0	0	4	0
Mixed herbaceous	44	18	16	11	0
Arrowweed	0	0	0	1	0
Tamarisk	49	22	23	14	0

Monitoring “green-up” response

- Normalized Difference Vegetation Index (NDVI) from Landsat 8
- Enhanced Vegetation Index (EVI) from the Moderate Resolution Imaging Spectrometer (MODIS) on the Terra satellite
- Combined these data to document changes in greenness from 2000 to present.

***Study conducted by P.L. Nagler (USGS), E.P. Glenn (UA), M. Gomez-Sapiens (UA), C.J. Jarchow (UA), J.A. Milliken (USBR)*



Preliminary Results:

- The 2014 pulse flow increased vegetation greenness and evapotranspiration (ET) in all reaches.
  - Increase in greenness from Aug. 2013 vs. Aug. 2014: Inundation zone = 43% Riparian zone = 23%
  - Of total greenness increase, 80% was outside of inundation zone.
  - Annual ET increased: 138 mcm in 2013 to 151 mcm in 2014.
  - The ET increase is equivalent to 10% of pulse flow (13 mcm)
- Vegetation became greener downstream; suggests that groundwater derived from the pulse flowed into the lower reaches and supported existing vegetation.
- ***Pulse flow reversed a 13-year decline in vegetation greenness***

Photos courtesy of Dale Turner

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Photos courtesy of Dale Turner

Summary and Next Steps

- The pulse flow successfully reached the entire river downstream of Morelos Dam, including sections of the river that were prepared for restoration. Restoration work in these sites continues by Sonoran Institute and Pronatura Noroeste.
- The pulse flow reached the Gulf of California on May 15, 2014.
- Groundwater levels rose as a result of the pulse flow.
- Both native and non-native vegetation germinated after the pulse flow.
- Base flows are being delivered by the Delta Water Trust.
- Monitoring of seedlings, groundwater, existing vegetation and wildlife (birds) will continue at regular intervals through 2017. Remote-sensing work also continues.

SAN LUIS RIO COLORADO, SONORA, MEXICO

Social impact: Community Support


Thank you!